CALCULATION OF CAST-IRON GIRDERS, &c.

The section that we employed to illustrate the use of the table at page 499 of the last number of The Builder, is a very common and a very useful one, being now almost universally employed in the construction of railways and other works where great strength is an object of consideration. If the contour be moulded into the figure of equal strength, and due attention be paid to the proportions of the parts, so as to equalize the shrinkage of the metal in cooling, this form is probably the very best that could be adopted, a remark that is in some measure confirmed by experience, and the extent of its application in all heavy structures. But although the form of section here alluded to is good, and very generally adopted by the most skilful engineers, there are some other forms which, on account of their convenience on certain occasions, ought not to be altogether neglected, especially as they present a very graceful appearance to the eye, and are by no means deficient in strength according to the quantity of material employed; we here allude to the open forms of beams, whether plain or feathered, and in order that our labours may be rendered as useful and instructive as possible, we shall here consider both these forms, and prove the utility of the table by applying it to the calculation of the load that ought not to be exceeded in any permanent bearer, where safety is an object of solicitude.

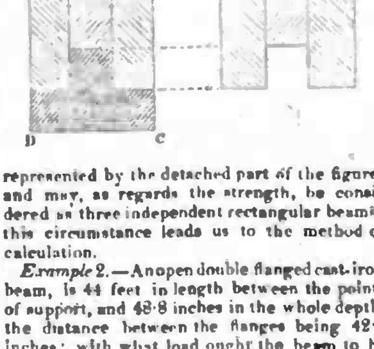
Let ABCD, fig. 1, represent the transverse section of a plain rectangular beam, and let the middle part E, denoted by the lighter shade be left out along the length of the beam, with the exception of cross stays to prevent the upper and lower parts AB and CD, distinguished by a darker shade, from coming together, and those cross stays may be made ornamental, in the form of arches or otherwise, according to the fancy of the architect or engineer.

With regard to the calculation of the permanent and safe load, with which a beam of this form ought to be charged, on the supposition that it is supported at the ends, and loaded at the middle of the length, we have only to consider the whole section ABCD as being entire, and to calculate its strength on that supposition, after the manner already exemplified at page 499. Do the same with the middle part E, considered as a separate rectangular section; then reduce the strength of the section E thus computed, in the proportion of the whole depth to the middle depth, and the difference between these two results will be the strength of the beam sought, including the effect produced by its own weight. From the result deduced in this way, subtract half the weight of the beam, and the remainder will be the load, beyond which the beam ought not to be charged, when intended as a permanent support.*

Example 1.—An open plane rectangular beam is loosely supported in a horizontal position on two walls, at the distance of 44 feet from each other; what load will it bear at the middle of its length, supposing the breadth to be seven inches, the whole depth four feet, and the depth of the middle part or opening three feet?

In the table opposite 48 inches in the left-hand column, and under 0 at the top of the page, we find 875·52 tons for the load corresponding to the whole depth of the section, when the breadth is one inch, and the length one foot or 12 inches: but the strength is directly as the breadth when the depth is given; hence we get $875 \cdot 52 \times 7 = 6128 \cdot 64$ tons, for the strength of a beam seven inches in breadth, 48 inches in depth and one foot in length. Again, opposite 36 inches in the left-hand column of the table, and under 0 at the top of the page, we find 492·48 tons, for the load corresponding to the depth of the middle or open part E, on the supposition that it is an independent rectangular section of the same breadth as the former; namely, seven inches; consequently, multiplying by the breadth, we get $492 \cdot 48 \times 7 = 3447 \cdot 36$ tons, for the central load on a beam 36 inches deep, seven inches broad, and one foot between the points of support. But this, by the laws of tension, must be reduced in the proportion of the whole depth to the depth of the middle part; that is, 48 : 36 : : 3447·36 : 2585·52 tons; let this be subtracted from the strength of the whole beam, and we get $6128 \cdot 64 - 2585 \cdot 52 = 3543 \cdot 12$, which being divided by the length between the points of support, gives $3543 \cdot 12 \div 44 = 80 \cdot 53$ tons very nearly, for the central and safe load, including the effect produced by the weight of the beam itself. Now, the area of the whole transverse section is $48 \times 7 = 336$ square inches; and that of the middle or open part, is $36 \times 7 = 252$ square inches; half the length of the beam being 22 feet; hence we obtain $(336 - 252) \times 3 \cdot 2 \times 22 = 5913 \cdot 6$ lbs. for half the weight of the beam, which being reduced to tons and subtracted from the load as calculated above, gives $80 \cdot 53 - 2 \cdot 64 = 77 \cdot 89$ tons, for the permanent central load which can be safely sustained by the given beam, without any danger of destroying the elastic force of the metal; and twice as much, or 155·78 tons, may be equally diffused over the length of the beam.

Another very elegant and useful form of section frequently employed in buildings, and to which our table is equally applicable, is that which has a web or flange on the upper and under side, with a portion of the middle part left out. This form of beam has a decided advantage over that which we have just considered, both as regards its stability and its strength; and it is besides particularly pleasing to the eye, for which reason it is well adapted for ornamental erections in places that are much exposed to public gaze. The drawing fig. 2 denotes the section here alluded to, and the manner in which we may conceive it to be constituted. The rectangle ABCD is the section considered as entire, and the rectangular portions E and F in lighter shade, are supposed to be taken away to form the flanges on the upper and under side of the beam along its whole length; the middle rectangular portion marked G being taken out to form the opening, which is understood to be braced with arches, or some other ornamental devices, for the purpose of preventing the upper and lower solid parts from coming together. The whole abstracted portions will therefore be as



represented by the detached part of the figure, and may, as regards the strength, be considered as three independent rectangular beams: this circumstance leads us to the method of calculation.

Example 2.—An open double flanged cast-iron beam, is 44 feet in length between the points of support, and 48·8 inches in the whole depth, the distance between the flanges being 42·4 inches; with what load ought the beam to be charged at the middle of its length, the greatest breadth being 9 inches, the flanges projecting on each side to the extent of 3¼ inches, and the depth of the central opening 38 inches?

Here then, we have first to calculate the strength of the whole section, on the supposition that it is entire, as represented by the rectangle ABCD. This done, we have next to calculate the three abstracted portions, E, F, G, considered as independent rectangular sections; or the portions E and F may be considered as one section, and calculated accordingly. Therefore, in the table opposite, 48 inches in the left hand column, and under ·8 at the top of the page, we find 904·9472 tons, for the strength of a beam of the given depth, 1 inch broad and 1 foot long. But the whole breadth, according to the question, is 9 inches, and by the principles of mechanics, the strength is directly as the breadth when the depth is given; therefore we have,

$904 \cdot 9472 \times 9 = 9144 \cdot 5248$ tons for the whole section.

The flanges project 3¼ inches on each side; this gives 6½ inches for the breadth of the two projections; but the distance between the flanges is 42·4 inches; therefore, in the table opposite 42 inches in the left-hand column and under ·4 at the top of the page, we find 683·1488 tons, corresponding to 1 inch in breadth and one foot long; hence, multiplying by the breadth, it is,

$683 \cdot 1488 \times 6\frac{1}{2} = 4440 \cdot 4672$ tons for the strength of E and F, jointly.

But by the laws of tension, this must be reduced in the proportion of the whole depth to the distance between the flanges or projections on the upper and lower side of the beam; that is, 48·8 : 42·4 :: 4440·4672 : 3855·111 tons nearly.

Again, the whole breadth of the section is 9 inches, and the joint breadth of the projections 6½ inches; consequently, the breadth of the middle part, or opening, is 2½ inches; but by the question, its depth is 38 inches; therefore, by the table we have 548·72 tons for the strength of 1 inch in breadth and 1 foot in length; and by multiplying by the breadth or thickness, we get $548 \cdot 72 \times 2\frac{1}{2} = 1371 \cdot 8$ tons for the tabular strength of the portion G, which must be reduced in the proportion of the whole depth to the depth of the opening; that is,

48·8 : 38 :: 1371·8 : 1068·205 tons nearly.

The reduced strength of the three parts, E, F, and G, taken conjointly, is therefore equal to $3855 \cdot 111 + 1068 \cdot 205 = 4926 \cdot 316$ tons; which being subtracted from the strength of the whole section, gives $9144 \cdot 5248 - 4926 \cdot 316 = 4218 \cdot 2088$ tons for the strength of a beam of the section 1 foot long; but by the laws of resistance, the strength is inversely as the length, when the breadth and depth are given; hence by division it is,

$$4218 \cdot 2088 \div 44 = 95 \cdot 868 \text{ tons},$$

including the effect produced by the weight of the beam. Now the sectional area of the solid portion of the beam is 68·6 square inches, and half the length is 22 feet; hence it is,

$$68 \cdot 6 \times 3 \cdot 2 \times 22 \div 2240 = 2 \cdot 156 \text{ tons},$$

and allowing one-tenth of this for the weight of the ornamental stays or braces, we get $2 \cdot 156 + \cdot 2156 = 2 \cdot 3716$ tons; so that the permanent safe load on the middle of the beam is $95 \cdot 868 - 2 \cdot 372 = 93 \cdot 496$ tons. T.

* In calculating the second example at page 499, the effect produced by half the weight of the beam was inadvertently omitted, the omission, however, is very easily supplied, for the sectional area is 158·41 square inches, and half the length of the beam between the points of support is 18 feet; hence we have $158 \cdot 41 \times 3 \cdot 2 \times 18 \div 2{,}240 = 4 \cdot 073$ tons, half the weight of the beam; therefore, by subtraction, we have 88·079 − 4·073, 83·999 tons, the permanent load sought. It is also stated in the question that the depth of the middle part is 2·5 inches; it ought to be 27·5 inches.

Singular Origin of a Fire.—The *Worcestershire Chronicle* says: On Sunday last, about two o'clock in the afternoon, a fire was discovered in the house of Cornelius J. Philbrick, Esq., surgeon, Mill-street, Worcester. It appears that in a bed-room with a southern aspect, a watercroft full of water, standing on a dressing-table, concentrated the calorific rays of the sun to a focus on an embroidered mat, which ignited, as also did another which adjoined it. The smell alarmed the inmates, and caused a search, which led to the discovery of the burning materials, and the timely prevention of further mischief.

The New Houses of Parliament.—An immense quantity of the slate from the quarries on the estate of the Knight of Kerry, Valentia Island, has been ordered for the new Houses of Parliament. It has been also ordered in large quantities for public buildings in France and other parts of the continent. So veined and variegated is it, and so susceptible of a high polish, that it is capable of being wrought into tables and other domestic articles. It is only a few years since that this quarry was discovered.—*Limerick Reporter.*